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The Psyllinae (Hemiptera, Psyllidae) from Gunung Kinabalu (Malaysia, Sabah)

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Abstract

Five species of Psyllinae are recognised from Gunung Kinabalu, all previously unknown, and are formally described and named: *Cacopsylla graciliforceps* **sp. nov.**, *C. kinabaluensis* **sp. nov.**, *C. myrsines* **sp. nov.**, *C. photiniae* **sp. nov.** and *Psylla cirrita* **sp. nov.** Another species similar to *P. cirrita* remains undescribed due to lack of sufficient material. Two Philippine species closely related to *C. kinabaluensis* are transferred to *Cacopsylla* as *Cacopsylla aranetae* (Miyatake, 1972), **comb. nov.** and *Cacopsylla bakeri* (Crawford, 1919), **comb. nov.** (both from *Psylla*). Three of the *Cacopsylla* species probably represent Palaearctic faunal elements (*Cacopsylla graciliforceps*, *C. myrsines* and *C. photiniae*). Host information is available only for *Cacopsylla myrsines* and *C. photiniae*, viz. *Myrsine dasyphylla* (Primulaceae) and *Photinia davidiana* (Rosaceae), respectively. *Myrsine* has not been previously reported as host genus of Psylloidea. The five new species bring the number of known Psylloidea species from Gunung Kinabalu to 22. The biogeographic relationships found in the flora, i.e. Oriental elements predominate at lower altitudes, and Himalayan and Australian elements are dominant at altitudes above 2500 m, are reflected in the psyllid fauna (Oriental 4 spp.; Australian 13 spp., Himalayan 3 spp.; unknown 2 spp.). Of the 22 species known from Gunung Kinabalu, 18 are only known from there. This high number is probably only partly due to endemism and is partly due to insufficient knowledge of the psyllid fauna of Borneo and of the tropics in general.

Key Words

Sternorrhyncha, Psylloidea, *Cacopsylla*, *Psylla*, systematics, phytophagy, distribution

Introduction

Psyllids (Psylloidea) constitute a superfamily of plant lice (Sternorrhyncha) characterised by their usually narrow host ranges within the eudicots, magnoliids and, exceptionally, monocots and conifers (Burckhardt et al. 2014; Ouvrard et al. 2015). Unlike the related aphids, adult psyllids, which are always winged, can survive for extended periods without feeding, allowing them to find and successfully colonise even rare hosts (Taylor and Moir 2009; Zhang et al. 2019). This may be one of the reasons why psyllids are most species-rich in the tropics and the southern hemisphere (Burckhardt et al. 2021), rather than in the northern temperate zones where aphids predominate (Dixon et al. 1987). Currently, just over 4000 species of psyllids have been described worldwide, but based on undescribed material available in museum collections, this is likely to be less than half of the species that actually exist (Burckhardt and Queiroz 2020). While the psyllid fauna of the temperate northern hemisphere, in particular the Palaearctic region, is reasonably well known, that of the tropics is not, and current ideas about host and distributional patterns of psyllids may change with a better knowledge on the tropical faunas.

Gunung Kinabalu in Borneo (Sabah, Malaysia), is well known for its high plant diversity rich in endemics.

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With almost 4100 m altitude, it is the highest mountain between the Himalayas and Mount Wilhelm in New Guinea. While its flora below 2500 m, most of which has been destroyed by human activities, is composed mostly of Oriental elements, that above 2500 m shares taxa with the Himalayas (e.g. Ericaceae) and Australia (e.g. Myrtaceae) (Cockburn 1978; Corner 1978; Beaman and Beaman 1990). These relationships seem to be reflected by the psyllid fauna of which 17 species have been reported. The Oriental genus *Paurocephala* Crawford, 1913 is represented by four species found at altitudes between 500–1850 m, developing on species of *Pterospermum* (Malvaceae), *Artocarpus* and *Ficus* (Moraceae) (Mifsud and Burckhardt 2002; Burckhardt et al. 2023). The other 13 species, representing the Australian faunal element, are associated with Myrtaceae and are members of the subfamily Spondyliaspidinae (Aphalaridae): *Boreioglycaspis* Moore, 1964 (7 spp. on *Syzygium* and *Tristaniopsis*) at altitudes from 1460–2700 m and *Ctenarytaina* Ferris & Klyver, 1932 (6 spp. on *Leptostermum* and *Syzygium*) at altitudes from 1700–3300 m (Burckhardt 1991; Burckhardt et al. 2020; Burckhardt 2021). So far, no psyllids with close relatives in the Himalayas have been reported from Gunung Kinabalu.

Here, species of Psyllinae (Psyllidae) collected on Gunung Kinabalu are described and their phylogenetic and biogeographic relationships are discussed. They belong to the predominantly north temperate genera *Cacopsylla* Ossiannilsson, 1970 and *Psylla* Geoffroy, 1762. The former is with over 450 species one of the largest psyllid genera (Ouvrard 2023) and is probably monophyletic apart from a few ill-placed species (Percy et al. 2018). The majority of the species develop on Elaeagnaceae, Rhamnaceae and Rosaceae (Rosales), Ericaceae (Ericales) and Salicaceae (Malpighiales). *Psylla* was redefined by Burckhardt et al. (2021) to include 24 species associated with Betulaceae. Prior to this narrow concept, the genus was used to include many unrelated species of Psyllidae that could not be assigned to other genera (Li 2011).

Material and methods

Material is deposited in the following institutions: **MHNG**–Muséum d'histoire naturelle, Genève, Switzerland; **NCHU**–National Chung Hsing University, Taiwan; **NHMB**–Naturhistorisches Museum, Basel, Switzerland. The morphological terminology follows Bastin et al. (2023). Measurements were taken as follows: adult body length from dry mounted specimens measuring the distance between fore margin of head and tip of forewings when folded over body; the other measurements were taken from slide mounted (*Cacopsylla*) or dry mounted (*Psylla*) specimens. The measurements and ratios are given as range. The psyllid nomenclature follows Ouvrard (2023) and the classification Burckhardt et al. (2021). The plant nomenclature accords with POWO (2023).

Results

Taxonomy

Cacopsylla graciliforceps sp. nov.

https://zoobank.org/FC470759-154A-417B-AE8F-F652BBF682B2

Figs 1, 2, 9, 13–15, 25–28

Type locality. Malaysia, Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, Panar Laban, 6.0594°N, 116.5665°E, 3300 m.

Material examined. ***Holotype.*** Malaysia • ♂; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8759; moss forest with Ericaceae and Myrtaceae, on *Vaccinium* (Ericaceae); MHNG, dry. ***Paratypes.*** Malaysia • 1 ♀; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail; 6.0475°N, 116.5620°E; 2830 m, 29.iv.1982; D. Burckhardt leg.; #F8274; *Leptospermum* forest; MHNG, dry. • 5 ♂, 5 ♀; same data but summit trail; 6.0578°N, 116.5662°E; 3230 m, 29.iv.1982; D. Burckhardt leg.; #F8277; *Leptospermum* forest, on *Leptospermum* (Myrtaceae); MHNG, NCHU, NHMB, dry. • 2 ♂; same data but summit trail; 6.0578°N, 116.5662°E; 3230 m, 29.iv.1982; D. Burckhardt leg.; #F8279; *Leptospermum* forest, on *Myrsine dasyphylla* (Primulaceae); MHNG, dry. • 6 ♂, 3 ♀; same data but summit trail; 6.0578°N, 116.5662°E; 3230 m, 29.iv.1982; D. Burckhardt leg.; #F8280; *Leptospermum* forest, on *Vaccinium coriaceum* (Ericaceae); MHNG, dry. • 1 ♂, 5 ♀; same data but summit trail; 6.0578°N, 116.5662°E; 3230 m, 29.iv.1982; D. Burckhardt leg.; #F8286; *Leptospermum* forest, Common trap; MHNG, dry. • 1 ♀; same data but summit trail near Lyang Lyang; 6.0430°N, 116.5591°E; 2620 m, 2.v.1987; D. Burckhardt and I. Löbl leg.; #F8751; open *Podocarpus*/*Leptospermum* forest; MHNG, dry. • 2 ♂, 8 ♀; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8756; moss forest with Ericaceae and Myrtaceae, on *Leptospermum recurvum* (Myrtaceae); MHNG, dry. • 1 ♀; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8757; moss forest with Ericaceae and Myrtaceae, on *Myrica javanica* (Myricaceae); MHNG, dry. • 15 ♂, 14 ♀; same data as holotype but MHNG, NHMB, dry, slide. • 4 ♂; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8761; moss forest with Ericaceae and Myrtaceae, on *Styphelia* sp. (Ericaceae); MHNG, dry. • 1 ♂, 4 ♀; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8762; moss forest with Ericaceae and Myrtaceae, on *Rhododendron* sp. (Ericaceae); MHNG, dry. • 3 ♂; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8764; moss forest with Ericaceae and Myrtaceae, on *Rhododendron* sp. (Ericaceae); MHNG,

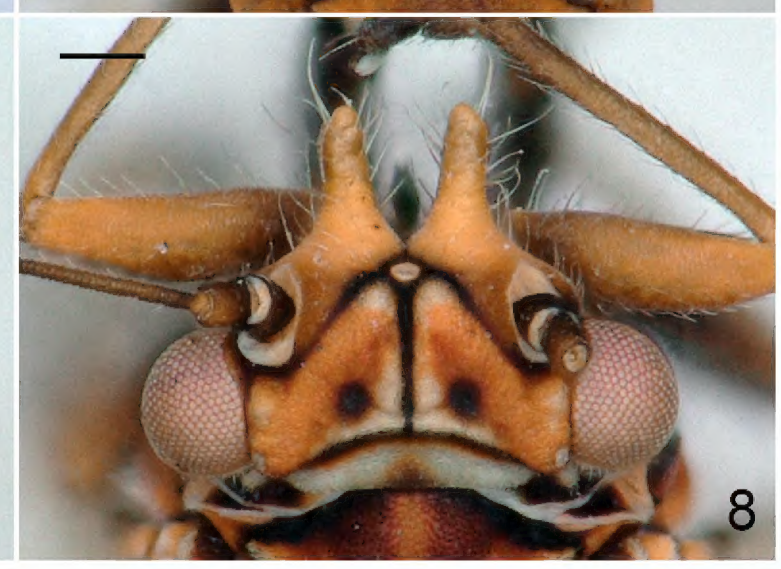
dry. • 2 ♂, 8 ♀; same data but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m, 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8765; moss forest with Ericaceae and Myrtaceae, on *Rhododendron rugosum* (Ericaceae); MHNG, dry. • 1 ♂; same data but headquarters; 1500 m, 8–16.v.1987; A. Smetana leg.; interception trap; MHNG, dry. • 14 ♂, 8 ♀; same data but below Laban Rata; 3155 m, 5.v.1987; A. Smetana leg.; MHNG, dry. • 8 ♂, 4 ♀; same data but Laban Rata; 3200 m, 9–20.v.1987; A. Smetana leg.; interception trap; MHNG, NHMB, dry, slide. • 5 ♂, 11 ♀; same data but Laban Rata; 3200 m, 4–8.v.1987; A. Smetana leg.; interception trap; MHNG, dry. • 2 ♂; same data but base of St. John's Peak; 3450–4000 m, 20.v.1987; A. Smetana leg.; MHNG, dry.

Diagnosis. Adult. Vertex 0.5 times as long as wide; genal processes 1.0–1.1 times as long as vertex along midline, slender, in basal third strongly, in apical two thirds weakly tapering to apex which is obliquely truncate or irregularly rounded, distinctly separated in the middle. Antenna 1.6–1.7 times as long as head width; relative length of flagellar segments as 1.0 : 0.7 : 0.6 : 0.6 : 0.5 : 0.5 : 0.2 : 0.3. Metatibia bearing small genual spine. Forewing oblong oval, widest in apical third, 3.4–3.8 times as long as head width, 2.3–2.5 times as long as broad; pterostigma moderately long, irregularly narrowing to apex, ending level with bifurcation of vein M; vein Rs weakly sinuous; m_1 cell value 2.1–2.4, cu_1 cell value 2.0–2.5; surface spinules present in all cells, relatively evenly spaced, forming irregular rhombs or squares; leaving broad spinule-free stripes along veins, absent from basal half of cell r_2; fields of surface spinules of marginal cells evenly widening to wing margin. Male proctiger tubular, weakly curved, 0.5–0.6 times as long as head width. Subgenital plate, in lateral view, subglobular, with relatively straight dorsal margin; sparsely beset with long setae in distal half. Paramere shorter than proctiger, in lateral view, digitiform, almost straight. Distal segment of aedeagus with lens-shaped apical dilation. Female proctiger 1.3–1.4 times as long as head width; dorsal margin slightly sinuous, irregularly narrowing to pointed apex. Female subgenital plate 0.5–0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex.

Description. Adult. ***Colouration.*** General body colour dark brown to almost black (Fig. 1). Head (Fig. 2) ochreous; vertex white along posterior margin medially and along base of coronal suture, each half with triangular dark brown patch. Antennal segments 1 and 2 light reddish brown, segments 3–8 yellow with dark apex becoming more extended from segment 3 to 8, segments 8 and 9 dark brown or black. Pronotum white in the middle and with two lateral white dots on either side. Mesopraescutum black with orange pattern consisting of a narrow, longitudinal orange line in the middle, a transverse band at the base and each a lateral patch on either side; lateral and posterior edges each with a white spot on either side. Mesoscutum with light brown longitudinal stripes. Legs yellow; profemora partly, and meso- and metafemora entirely dark brown. Forewing (Fig. 9) membrane transparent, almost colourless; veins ochreous to brown, becoming darker towards apex; apex of clavus brown. Younger specimens with more extended ochreous and brown colour.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body length ♂ 2.8–3.1 mm, ♀ 2.9–3.4 mm (10 ♂, 10 ♀). Head deflexed 45° from longitudinal body axis (Fig. 1); slightly narrower than mesoscutum. Vertex rhomboidal, 0.5 times as long as wide, weakly concave at base, bearing short sparse setae and imbricate microsculpture; preocular sclerite not developed; genal processes 1.0–1.1 times as long as vertex along midline, slender, in basal third strongly, in apical two thirds weakly tapering to apex which is obliquely truncate or irregularly rounded, distinctly separated in the middle, evenly beset with sparse long setae, those along lateral margin near apex slightly longer than the others (Fig. 2); eyes hemispherical. Rostrum 0.4–0.5 times as long as head width, in lateral view mostly hidden by mesosternum and only apical segment visible. Antenna 1.6–1.7 times as long as head width; relative length of flagellar segments as 1.0 : 0.7 : 0.6 : 0.6 : 0.5 : 0.5 : 0.2 : 0.3; antennal segment 3 longest; relative length of segment 10 and terminal antennal setae as 1.0 : 1.6 : 1.4. Metatibia 0.7–0.8 times as long as head width, bearing small genual spine, weakly widening to apex, with 1+3+1 apical spurs. Forewing (Fig. 9) oblong oval, widest in apical third, 3.4–3.8 times as long as head width, 2.3–2.5 times as long as broad, costal margin irregularly curved, relatively evenly rounded apically; pterostigma moderately long, at base narrower than adjacent part of cell r_1, irregularly narrowing to apex, ending level with bifurcation of vein M; vein C+Sc weakly, relatively evenly curved; vein M+Cu longer than half length of R; vein Rs weakly sinuous; m_1 cell value 2.1–2.4, cu_1 cell value 2.0–2.5; surface spinules present in all cells, relatively evenly spaced, forming irregular rhombs or squares; leaving broad spinule-free stripes along veins, absent from basal half of cell r_2; fields of surface spinules of marginal cells evenly widening to wing margin.

Male terminalia as in Figs 13–15. Proctiger tubular, weakly curved, 0.5–0.6 times as long as head width; beset with long, dense setae in apical two thirds. Subgenital plate, in lateral view, subglobular, with relatively straight dorsal margin; sparsely beset with long setae in distal half. Paramere shorter than proctiger, in lateral view, digitiform, almost straight; weakly, slightly irregularly narrowing to rounded apex; apex, in dorsal view, with sclerotised toothlet pointing antero-mediad; in caudal view curved; outer face relatively evenly beset with moderately long setae; inner face densely beset with long bristles, denser basally along posterior margin. Aedeagus long and slender; distal segment of aedeagus slender in basal three quarters, lens-shaped in apical quarter; sclerotised end tube of ductus ejaculatorius short, weakly curved. – Female terminalia as in Figs 25–28. Proctiger 1.3–1.4 times as long as head width, 4.8–5.0 times as long as circumanal ring which consists of two unequal rows of pores; dorsal margin slightly sinuous, irregularly narrowing to pointed apex; sparsely beset with short setae in basal half and with



Figures 1–8. *Cacopsylla* spp. **1, 3, 5, 7.** Habitus, in lateral view; **2, 4, 6, 8.** Head, in dorsal view; **1, 2.** *C. graciliforceps*; **3, 4.** *C. kinabaluensis*; **5, 6.** *C. myrsines*; **7, 8.** *C. photiniae*.

a submedian longitudinal row of moderately long setae and a lateral band of peg setae on either side in apical half. Subgenital plate 0.5–0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex; apical three quarters beset with short setae laterally and long setae ventrally. Dorsal and ventral valvulae weakly curved; lateral valvula narrowly rounded apically.

Measurements in mm (3 ♂, 3 ♀). Head width 0.68–0.74; antenna length 1.12–1.24; forewing length 2.34–2.76; length of male proctiger 0.36–0.38; paramere length 0.28–0.30; length of distal segment of aedeagus 0.24–0.26; female proctiger length 0.96–1.00.

Fifth instar immature unknown.

Etymology. From Latin gracilis = slender, thin, slim and forceps = pair of tongs, pincers, referring to the slender parameres.

Distribution. Malaysia: Sabah, Gunung Kinabalu, at altitudes between 2600 m and 4000 m. The single male

found in a trap at 1500 m was probably blown there by the wind.

Host plant, biology and habitat. Unknown. Almost half of the adults were collected on species of Ericaceae (*Rhododendron*, *Styphelia* and *Vaccinium*) which are likely hosts. The species was found in *Leptospermum* and open *Podocarpus*/*Leptospermum* forests as well as in moss forest with Ericaceae and Myrtaceae.

Comments. *Cacopsylla graciliforceps* resembles 11 Palaearctic *Cacopsylla* species associated with Ericaceae in the antennae shorter than twice head width, the forewing with a weakly curved costal margin and fields of surface spinules widening towards the wing margin, as well as in the slender, simple paramere. It differs from *Cacopsylla borealis* Nokkala & Nokkala, 2019, *C. fraudatrix* Labina & Kuznetsova, 2012, *C. lapponica* Nokkala & Nokkala, 2019, *C. ledi* (Flor, 1861), *C. myrtilli* (Wagner, 1947), *C. rhododendri* (Puton, 1871) and *C. vaccinii* (Miyatake, 1964) in the much longer female terminalia, and from *C. fengqingica* Li, 2011, *C. lyoniae* Li, 2011, *C. nigriantennata* (Kuwayama, 1908) and *C. pieridis* (Li & Yang, 1987) in the straight, digitiform paramere with subparallel margins in lateral view (versus slightly sinuate and irregularly narrowing in the first three species and slightly sinuous and lamellar in the last species).

Cacopsylla kinabaluensis sp. nov.

https://zoobank.org/1D1952C5-58BD-4031-8803-CDBCF930A7BE

Figs 3, 4, 10, 16–18, 29–31

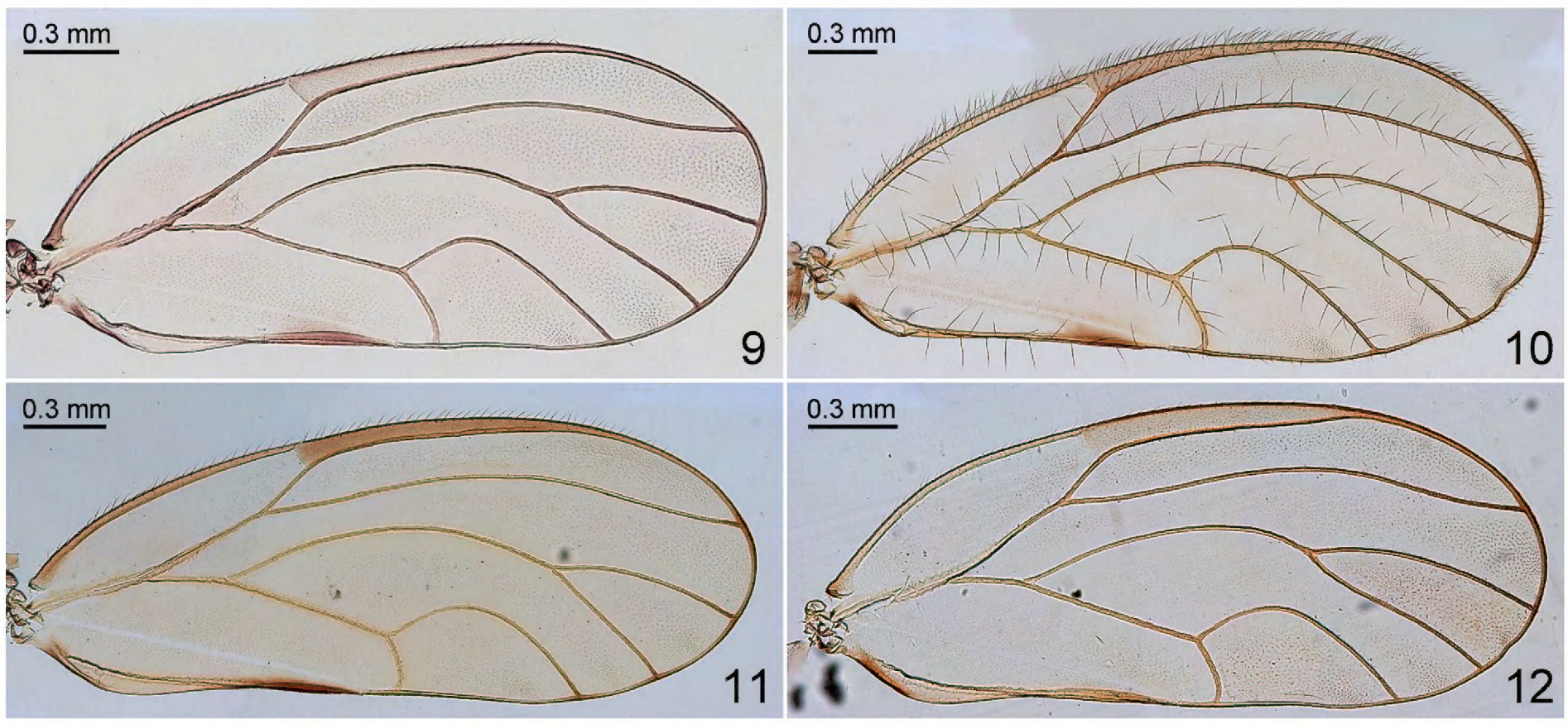
Type locality. Malaysia, Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail below Layang Layang, 6.0439°N, 116.5602°E, 2640 m.

Material examined. ***Holotype.*** Malaysia • ♂; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail below Layang Layang; 6.0439°N, 116.5602°E; 2640 m; 1.v.1987; D. Burckhardt and I. Löbl leg.; #F8740; moss forest; MHNG, dry. ***Paratypes.*** Malaysia • 1 ♂, 1 ♀; same but summit trail; 6.0416°N, 116.5565°E; 2620 m; 29.iv.1982; D. Burckhardt leg.; #F8285; moss forest; MHNG, dry. • 2 ♂; same but summit trail below Layang Layang; 6.0419°N, 116.5578°E; 2560 m; 1.v.1987; D. Burckhardt and I. Löbl leg.; #F8735; moss forest, on *Syzygium* sp. (Myrtaceae); MHNG, dry. • 10 ♂, 3 ♀; same as holotype; MHNG, NHMB, dry, slide. • 1 ♂; same but below Layang Layang; 2600 m; 28.v.1987; A. Smetana leg.; MHNG, dry.

Diagnosis. Adult. Vertex 0.3–0.4 times as long as wide; genal processes 1.9 times as long as vertex along midline, slender, tubular, widely separated in the middle. Antenna 3.4–3.6 times as long as head width; relative length of flagellar segments as 1.0 : 0.9 : 0.9 : 1.0 : 0.9 : 0.8 : 0.2 : 0.2. Metatibia lacking genual spine. Forewing widest in apical third, 3.4–3.6 times as long as head width, 2.2–2.3 times as long as broad, costal margin curved; pterostigma short, regularly narrowing to apex, ending level with bifurcation of vein M; vein Rs evenly curved, subparallel with costal margin; m_1 cell value 2.4–2.7, cu_1 cell value 2.1; veins beset with very long, conspicuous setae; surface spinules restricted to apices of cells except for cells r_1 and cu_2 where they cover the entire cell leaving broad spinule-free stripes along the veins; relatively evenly spaced forming irregular rhombs or squares, absent from basal half and from base of cell r_2; fields of surface spinules in each of the marginal cells widening to wing margin. Male proctiger narrowly tubular, weakly sinuate, 0.5 times as long as head width. Subgenital plate, in lateral view, subglobular, slightly elongate, with weakly concave dorsal margin. Paramere slightly longer than proctiger, in lateral view, narrowly digitiform, weakly sinuate; inner face with a patch of very dense thick bristles in basal third. Distal segment of aedeagus hardly inflated apically. Female proctiger 1.0 times as long as head width; dorsal margin slightly sinuous, irregularly narrowing to subacute apex. Female subgenital plate 0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex.

Description. Adult. ***Colouration.*** General body colour ochreous, mixed with white and almost black elements (Fig. 3). Head (Fig. 4) ochreous; vertex white along posterior margin in the middle and along base of coronal suture; each half of vertex with small dark brown patch; area around median ocellus black; genal processes, except for base, ochreous to red. Antennal segments 1 and 2 straw-coloured, segment 3 yellow with brown apical third, segments 4–10 dark brown or black. Pronotum almost black in anterior half and along a narrow stripe in the middle of posterior half, which is white otherwise. Mesopraescutum mostly ochreous with two semicircular patches along posterior margin on either side; the two median white patches are separated from ochreous part by a thick, curved, dark brown transverse line. Mesoscutum with dark brown longitudinal stripes. Mesoscutellum dark brown with wide white margins. Metapostnotum reddish with brown dot in the middle. Femora partly brown, meso- and metatarsi almost black. Forewing membrane transparent, colourless; veins light brown, becoming darker towards apex; apex of clavus brown. Younger specimens with more expanded light colour.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body length ♂ 4.0–4.4 mm, ♀ 4.5–4.8 mm (10 ♂, 3 ♀). Head deflexed 45–90° from longitudinal body axis (Fig. 3); as wide as mesoscutum. Vertex rhomboidal, short, 0.3–0.4 times as long a wide, concave at base, bearing long setae and imbricate microsculpture; preocular sclerite narrow; genal processes 1.9 times as long as vertex along midline, slender, tubular, widely separated in the middle, evenly beset with sparse long setae (Fig. 4); eyes hemispherical. Rostrum 0.3–0.5 times as long as head width, in lateral view mostly hidden by mesosternum and only apical segment visible. Antenna 3.4–3.6 times as long as head width; relative length of flagellar segments as 1.0 : 0.9 : 0.9 : 1.0 : 0.9 : 0.8 : 0.2 : 0.2; antennal segment 3 longest; relative length of segment 10 and terminal antennal setae as 1.0 : 1.2 : 1.2. Metatibia



Figures 9–12. *Cacopsylla* spp., forewing. **9.** *C. graciliforceps*; **10.** *C. kinabaluensis*; **11.** *C. myrsines*; **12.** *C. photiniae*.

0.9 times as long as head width, lacking genual spine, weakly widening to apex, with 1+3+1 apical spurs. Forewing (Fig. 10) oval, widest in apical third, 3.4–3.6 times as long as head width, 2.2–2.3 times as long as broad, costal margin irregularly curved, relatively evenly rounded apically; pterostigma relatively short, at base narrower than adjacent part of cell r_1, regularly narrowing to apex, ending level with bifurcation of vein M; vein C+Sc weakly, relatively evenly curved; vein M+Cu longer than half length of R; vein Rs evenly curved, subparallel with costal margin; m_1 cell value 2.4–2.7, cu_1 cell value 2.1; veins beset with very long, conspicuous setae (Fig. 10); surface spinules restricted to apices of cells except for cells r_1 and cu_2 where they cover the entire cell leaving broad spinule-free stripes along the veins; relatively evenly spaced forming irregular rhombs or squares, absent from basal half and from base of cell r_2; fields of surface spinules in each of the marginal cells widening to wing margin.

Male terminalia as in Figs 16–18. Proctiger narrowly tubular, weakly sinuate, 0.5 times as long as head width; densely beset with long, setae except for base. Subgenital plate, in lateral view, subglobular, slightly elongate, with weakly concave dorsal margin; densely beset with moderately long setae except for basally and dorso-apically. Paramere slightly longer than proctiger, in lateral view, narrowly digitiform, weakly sinuate; irregularly narrowing to blunt apex; apex, in dorsal view, with sclerotised tooth pointing antero-mediad; in caudal view curved, basal half strongly expanded medially and densely beset with thick bristles; outer face beset with moderately long setae; inner face with a patch of very dense thick bristles in basal third and a few sparse bristles apically, otherwise bare except for two long setae. Aedeagus long and very slender; distal segment of aedeagus hardly inflated apically, rounded; sclerotised end tube of ductus ejaculatorius short, weakly curved. – Female terminalia as in Fig. 29–31. Proctiger 1.0 times as long as head width, 3.5 times as long as circumanal ring which consists of two unequal rows of pores; dorsal margin slightly sinuous, irregularly narrowing to subacute apex; densely beset with moderately long setae in median third and with a submedian longitudinal row of long setae and a lateral band of peg setae on either side in apical third. Subgenital plate 0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex; except for base beset with long setae becoming sparser towards apex and, in apical third, with lateral peg setae. Dorsal and ventral valvulae curved; lateral valvula narrowly rounded apically.

Measurements in mm (1 ♂, 1 ♀). Head width 0.98–1.06; antenna length 2.88–3.48; forewing length 3.30–3.80; length of male proctiger 0.50; paramere length 0.56; length of distal segment of aedeagus 0.40; female proctiger length 1.04.

Fifth instar immature unknown.

Etymology. Named after its provenience, the Gunung Kinabalu.

Distribution. Malaysia: Sabah, Gunung Kinabalu, at around 2600 m altitude.

Host plant, biology and habitat. Unknown. Two adults were collected on *Syzygium* sp. (Myrtaceae) which is an unlikely host. All specimens were collected in moss forest.

Comments. *Cacopsylla kinabaluensis* is morphologically similar to *Psylla aranetae* Miyatake, 1972 and *Psylla bakeri* Crawford, 1919, two species described from the Philippines without host data and based only on one and two females, respectively (Crawford 1919; Miyatake 1972). The three species share the multi-coloured body, the short vertex, the long tubular, medially widely separated genal processes, the long antennae (> twice head width), the absence of a genual spine and 1+3+1 apical spurs on the metatibiae, the oval forewings with curved costal margin and narrow, relatively short pterostigma, and the moderately long, cuneate female terminalia with

apically subacute or pointed proctiger and subgenital plate. The three morphologically similar species constitute a putatively monophyletic group and are congeneric. Apart from the very long antennae and the tubular, medially widely separated genal processes the three species fit the concept of *Cacopsylla* by Ossiannilsson (1992). For this reason, the two Philippine species are transferred here to *Cacopsylla* as *Cacopsylla aranetae* (Miyatake, 1972), comb. nov. and *Cacopsylla bakeri* (Crawford, 1919), comb. nov. (both from *Psylla*). Immatures will be necessary to test this generic placement.

Cacopsylla kinabaluensis and *C. aranetae* differ from *C. bakeri* in the larger body size (forewing length > 3.3 mm versus 2.3 mm) and the longer cell m_1 (cell m_1 value > 2.0 versus < 2.0; length ratio of veins M/M_{1+2} ca. 1 versus ca. 2) (Crawford 1919). *Cacopsylla kinabaluensis* differs from *C. aranetae* in the longer genal processes (length ratio of vertex/genal processes 1.9 versus 1.3), the longer antenna (antenna length/head width ration > 2.9 versus 2.2) and the sinuate (versus slightly concave) dorsal outline, in lateral view, of the female proctiger (Miyatake 1972).

Cacopsylla myrsines sp. nov.

https://zoobank.org/9CD9AD80-6C64-41F4-82D9-4D69EB5FF86F

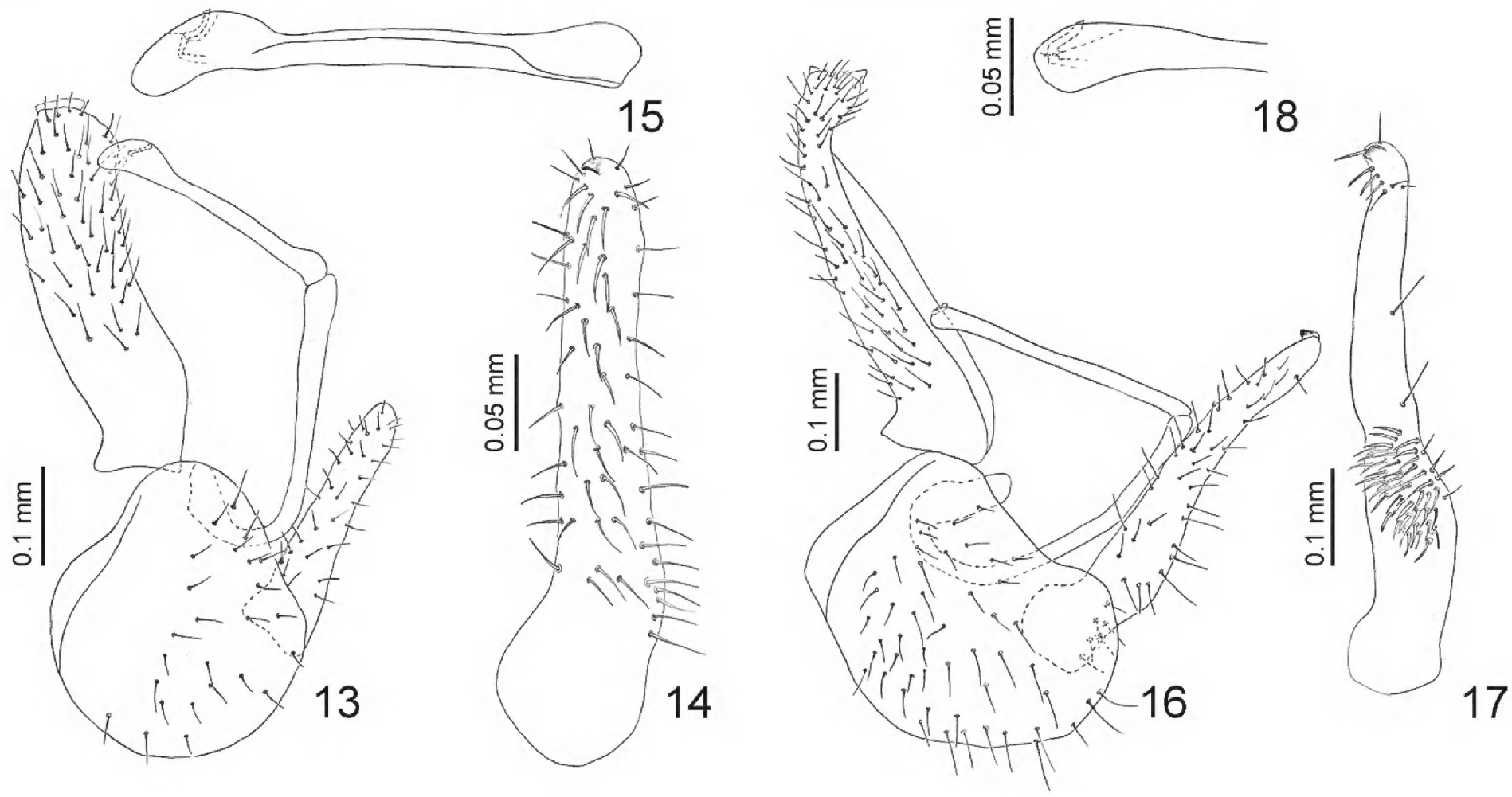
Figs 5, 6, 11, 19–21, 32, 34–36

Type locality. Malaysia, Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, 6.0578°N, 116.5662°E, 3230 m.

Material examined. ***Holotype.*** Malaysia • ♂; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail; 6.0578°N, 116.5662°E; 3230 m; 29.iv.1982; D. Burckhardt leg.; #F8279; *Leptospermum* forest, on *Myrsine dasyphylla* (Primulaceae); MHNG, dry. ***Paratypes.*** Malaysia • 3 ♂, 2 ♀, 2 immatures, 3 skins; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail; 6.0449°N, 116.5604°E; 2670 m; 29.iv.1982; D. Burckhardt leg.; #F8269; *Leptospermum* forest, on *Myrsine dasyphylla* (Primulaceae); MHNG, NHMB, slide, 70% ethanol. • 24 ♂, 11 ♀, same data as holotype; MHNG, NCHU, NHMB, dry, slide. • 2 ♂; same but summit trail; 6.0449°N, 116.5604°E; 2670 m; 4.v.1982; D. Burckhardt leg.; #F82106; *Leptospermum* forest, *Myrsine dasyphylla* (Primulaceae); MHNG, dry. • 1 ♀; same but summit trail near Lyang Lyang; 6.0430°N, 116.5591°E; 2620 m; 2.v.1987; D. Burckhardt leg.; #F8744/45; open *Podocarpus*/*Leptospermum* forest; MHNG, dry. • 2 ♀; same but summit trail near Lyang Lyang; 6.0445°N, 116.5605°E; 2650 m; 2.v.1987; D. Burckhardt leg.; #F8248; open *Podocarpus*/*Leptospermum* forest; MHNG, dry. • 1 ♂, same but summit trail near Lyang Lyang; 6.0430°N, 116.5591°E; 2620 m; 2.v.1987; D. Burckhardt leg.; #F8252; open *Podocarpus*/*Leptospermum* forest; MHNG, dry.

Diagnosis. Adult. Vertex 0.5–0.6 times as long as wide; genal processes 1.0–1.3 times as long as vertex along midline, narrowly conical, separated in the middle, evenly beset with sparse long setae, apex subacute. Antenna 2.1–2.2 times as long as head width; relative length of flagellar segments as 1.0 : 0.6 : 0.6 : 0.6 : 0.6 : 0.5 : 0.3 : 0.3. Metatibia with small indistinct genual spine. Forewing oblong-oval, widest in the middle, 3.8–4.1 times as long as head width, 2.5–2.6 times as long as broad, costal margin curved; pterostigma long, irregularly narrowing to apex, with subparallel margins in the middle, ending distal to bifurcation of vein M; vein Rs evenly curved, subparallel with costal margin except for apex which is slightly curved towards costal margin of wing; m_1 cell value 1.9–2.2, cu_1 cell value 2.9–3.3; veins beset with short setae; surface spinules present in all cells, leaving broad spinule-free stripes along the veins; absent from basal three quarters of cell c+sc and basal third or half of cell r_2; fields of surface spinules in each of the marginal cells widening to wing margin; relatively evenly spaced, forming irregular rhombs or squares. Male proctiger narrowly tubular, weakly sinuate. Subgenital plate, in lateral view, subglobular, with almost straight dorsal margin. Paramere longer than proctiger, in lateral view, narrowly digitiform, almost straight; inner face with a longitudinal stripe of thick bristles except for basal quarter and sparse setae along fore and hind margin. Distal segment of aedeagus weakly inflated apically, rounded. Female proctiger 1.2–1.3 times as long as head width; dorsal margin slightly sinuous, irregularly narrowing to pointed apex. Subgenital plate 0.5 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex. – Fifth instar immature. Body 1.3 times as long as wide. Antenna 1.0–1.1 times as long as forewing pad; segments 4–6 1.0 times as long as segment 7; lacking capitate setae on flagellum. Forewing pad with a single long, thick, apically pointed marginal seta apically, lacking dorsal macroscopic setae; hindwing pad with 2 long, thick, apically pointed, marginal setae subapically, lacking dorsal macroscopic setae. Caudal plate 0.6–0.7 times as long as wide; lacking marginal sectasetae, with 5+5 long and a few short and medium long marginal thick, apically pointed setae, lacking dorsal macroscopic setae. Outer circumanal ring small, its length along longitudinal body axis much larger than its distance from caudal margin of caudal plate; circular, closed anteriorly; consisting of a single row of pores.

Description. Adult. ***Colouration.*** General body colour light orange brown (Fig. 5). Head (Fig. 6) ochreous with brown patches on either side of coronal suture of vertex and yellow genal processes. Antennal segments 1 and 2 light brown, segments 3–5 yellow with brown apices, segments 6–8 dark brown with almost black apices, segments 9 and 10 almost black. Pronotum with each a lateral and sublateral dark brown dot on either side. Mesopraescutum mostly dark brown, orange-yellowish laterally. Mesoscutum with dark brown longitudinal stripes. Metapostnotum almost black, orange-yellowish laterally. Fore and mid legs and metafemora brown. Forewing membrane semitransparent, yellow to light brown; veins light brown, costal margin, pterostigma, apical margin and apex of clavus brown. Younger specimens with more expanded light colour.



Figures 13–24. *Cacopsylla* spp., male terminalia. **13, 16, 19, 22.** Male terminalia, in lateral view; **14, 17, 20, 23.** Inner face of paramere; **15, 21, 24.** Distal aedeagal segment, same scale as paramere; **18.** apex of distal aedeagal segment. **13–15.** *C. graciliforceps*; **16–18.** *C. kinabaluensis*; **19–21.** *C. myrsines*; **22–24.** *C. photiniae*.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body length ♂ 3.1–3.4 mm, ♀ 3.4–3.9 mm (10 ♂, 10 ♀). Head deflexed 45–80° from longitudinal axis of body (Fig. 5); as wide as mesoscutum. Vertex (Fig. 6) rhomboidal, 0.5–0.6 times as long as wide, concave at base, bearing microscopic setae and imbricate microsculpture; preocular sclerite narrow; genal processes 1.0–1.3 times as long as vertex along mid-line, narrowly conical, separated in the middle, evenly beset with sparse long setae, apex subacute (Fig. 6); eyes hemispherical. Rostrum 0.3–0.4 times as long as head width, in lateral view mostly hidden by mesosternum and only apical segment visible. Antenna 2.1–2.2 times as long as head width; relative length of flagellar segments as 1.0 : 0.6 : 0.6 : 0.6 : 0.6 : 0.5 : 0.3 : 0.3; antennal segment 3 longest; relative length of segment 10 and terminal antennal setae as 1.0 : 0.7 : 0.9. Metatibia 0.7–0.8 times as long as head width, with small indistinct genual spine, weakly widening to apex, with 1+3+1 apical spurs. Forewing (Fig. 11) oblong-oval, widest in the middle, 3.8–4.1 times as long as head width, 2.5–2.6 times as long as broad, costal margin irregularly curved, relatively evenly rounded apically; pterostigma relatively long, at base narrower than adjacent part of cell r_1, irregularly narrowing to apex,

with subparallel margins in the middle, ending distal to bifurcation of vein M; vein C+Sc weakly, relatively evenly curved; vein M+Cu longer than half length of R; vein Rs evenly curved, subparallel with costal margin except for apex which is slightly curved towards costal margin of wing; m_1 cell value 1.9–2.2, cu_1 cell value 2.9–3.3; veins beset with short setae; surface spinules present in all cells, leaving broad spinule-free stripes along the veins; absent from basal three quarters of cell c+sc and basal third or half of cell r_2; fields of surface spinules in each of the marginal cells widening to wing margin; relatively evenly spaced forming irregular rhombs or squares.

Male terminalia as in Figs 19–21. Proctiger narrowly tubular, weakly sinuate, 0.4 times as long as head width; densely beset with long setae in apical three quarters. Subgenital plate, in lateral view, subglobular, with almost straight dorsal margin; densely beset with moderately long setae along a broad transverse band stretching from dorsal margin to postero-ventral margin and a patch postero-apically. Paramere longer than proctiger, in lateral view, narrowly digitiform, almost straight; evenly narrowing to blunt apex; apex, in dorsal view, with sclerotised apex forming an inward directed, slender process which is obliquely truncate apically; parameres, in caudal view, forming narrow O; outer face beset with moderately long setae in apical two thirds; inner face with a longitudinal stripe of thick bristles except for basal quarter and sparse setae along fore and hind margin; apex forming sclerotised tooth. Aedeagus long and very slender; distal segment weakly inflated apically, rounded; sclerotised end tube of ductus ejaculatorius short, sinuate. – Female terminalia as in Fig. 32. Proctiger 1.2–1.3 times as long as head width, 3.5–3.8 times as long as circumanal ring which consists of two unequal rows of pores; dorsal margin slightly sinuous, irregularly narrowing to pointed apex; beset with moderately long setae in median third, with a submedian longitudinal row of long setae in apical half and a lateral band of peg setae on either side in apical third. Subgenital plate 0.5 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex; except for base beset with long setae laterally and apically, in apical third, and with a lateral band of peg setae. Dorsal and ventral valvulae curved; lateral valvula narrowly rounded apically.

Measurements in mm (2 ♂, 2 ♀). Head width 0.70–0.76; antenna length 1.48–1.68; forewing length 2.74–3.14; length of male proctiger 0.28–0.30; paramere length 0.36–0.40; length of distal segment of aedeagus 0.28; female proctiger length 0.90–0.92.

Fifth instar immature. Colouration of ethanol preserved specimens. Dorsal sclerites brown, membranes colourless. Cephalothorax yellow anteriorly, becoming gradually darker towards rear. Antennal segments 1–3 yellow, segments 4–6 brown, segment 7 dark brown. Thoracic and basal abdominal sclerites slightly darker than wing pads and caudal plate. Legs yellow, tarsi light brown.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body (Fig. 34) 1.3 times as long as wide. Antenna 7-segmented, 1.0–1.1 times as long as forewing pad; segments 4–6 1.0 times as long as segment 7; lacking capitate setae on flagellum. Thoracic tergites small. Forewing pad broad, rounded apically, with a single long, thick, apically pointed marginal seta apically, lacking dorsal macroscopic setae; hindwing pad with 2 long, thick, apically pointed, marginal setae subapically, lacking dorsal macroscopic setae. Caudal plate 0.6–0.7 times as long as wide; lacking marginal sectasetae, with 5+5 long, and a few short and medium long marginal thick, apically pointed setae (Fig. 35), lacking dorsal macroscopic setae. Outer circumanal ring (Fig. 36) small, its length along longitudinal body axis much larger than its distance from caudal margin of caudal plate; circular, complete (closed) anteriorly; consisting of a single row of narrowly oval pores.

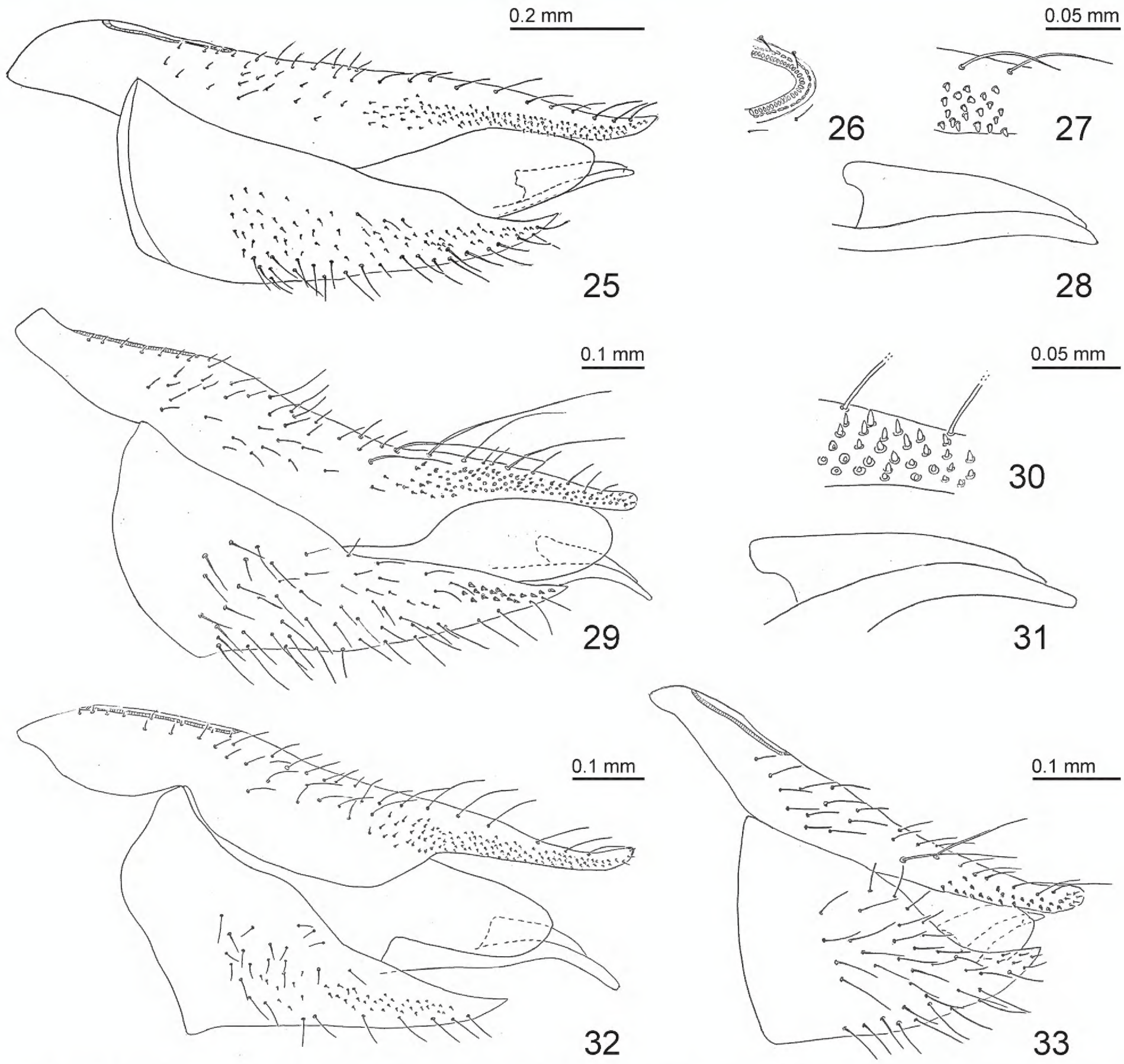
Measurements (in mm) (2 individuals). Body length 1.82–1.92; antennal length 0.80–0.84; length of forewing pad 0.78–0.80.

Etymology. Named after its host, *Myrsine*.

Distribution. Malaysia: Sabah, Gunung Kinabalu, at altitudes between 2600–3300 m.

Host plant, biology and habitat. *Myrsine dasyphylla* Stapf (Primulaceae), an endemic of Borneo (POWO 2023). *Cacopsylla myrsines* was found in *Leptospermum* and open *Podocarpus*/*Leptospermum* forests.

Comments. *Cacopsylla myrsines* shares the slender genal processes which are as long as or longer than the coronal suture, the presence of a small genual spine and 1+3+1 apical spurs on the metatibiae, the lack of a distinct dark pattern on the forewings, the simple slender paramere, and the long female proctiger with a weakly sinuate dorsal margin with following species developing on Elaeagnaceae: *Cacopsylla albiumbellatae* (Li & Yang, 1987), *C. bomihippophaes* (Li & Yang, 1988), *C. foliprominens* Li, 2005, *C. graciscapa* Li, 2005, *C. hippophaes* (Foerster, 1848), *C. jinaphippophae* Li, 2011, *C. longicornis* Li & Yang, 1992, *C. mucronulata* Li, 2011, *C. nasuta* (Horváth, 1904), *C. nigraimaculata* Li, 2011, *C. qinlingielaeagnae* Li, 2005, *C. tingriana* (Li & Yang, 1987), *C. wushanelaeagna* Li, 1997 and *C. zetterstedti* (Thomson, 1877). It differs from *C. albiumbellatae*, *C. bomihippophaes*, *C. foliprominens*, *C. graciscapa*, *C. mucronulata*, *C. qinlingielaeagnae* and *C. nigraimaculata* in the straight paramere, in lateral view (versus sinuate), from *C. hippophaes*, *C. jinaphippophae*, *C. longicornis*, *C. nasuta* and *C. zetterstedti* in the lens-shaped apical inflation of the distal segment of the aedeagus (versus hook-shaped), and from *C. tingriana* and *C. wushanelaeagna* in the relatively narrower forewings (forewing length/width ratio 2.5–2.6 versus 2.2–2.3). Immatures of *C. myrsines* differ from the species listed above, as far as their immatures are known, in the presence of thick, apically pointed (Fig. 35) rather than capitate (Fig. 38) marginal setae on the wing pads and caudal plate. Similar pointed marginal setae are also present in other *Cacopsylla* species associated with Elaeagnaceae (*C. elaeagni* (Kuwayama, 1908) or *C. fulguralis* (Kuwayama, 1908)),



Figures 25–33. *Cacopsylla* spp., female terminalia. **25, 29, 32, 33.** Female terminalia, in lateral view; **26.** Distal part of circumanal ring, in dorsal view; **27, 30.** Subapical portion of proctiger, in lateral view; **28, 31.** Dorsal and ventral valvulae. **25–28.** *C. graciliforceps*; **29–31.** *C. kinabaluensis*; **32.** *C. myrsines*; **33.** *C. photiniae*.

Araliaceae (*C. fatsiae* (Jensen, 1957), *C. boninofatsiae* Inoue & Miyatake, 2001)) or Lardizabalaceae (*C. coccinea* (Kuwayama, 1908)). *Cacopsylla myrsines* differs from these species in details of the male and female terminalia. It is not known whether the *Cacopsylla* species associated with the three plant families are closely related phylogenetically.

Cacopsylla photiniae sp. nov.

https://zoobank.org/0CC3863F-A3E9-413E-B004-00987A9878BC

Figs 7, 8, 12, 22–24, 33, 37–39

Type locality. Malaysia, Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit region, 6.0687°N, 116.5617°E, 3890 m.

Material examined. *Holotype.* Malaysia • ♂; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit region; 6.0687°N, 116.5617°E; 3890 m; 30.iv.1982; D. Burckhardt leg.; #F8281; subalpine scrub, on *Photinia davidiana* (Rosaceae); MHNG, dry. ***Paratypes.*** Malaysia • 30 ♂, 15 ♀; same as holotype but MHNG, NCHU, NHMB, dry, slide. • 3 ♂, 6 ♀; same but summit region; 6.0687°N, 116.5617°E; 3890 m; 30.iv.1982; D. Burckhardt leg.; #F8282; subalpine scrub, on *Leptospermum recurvum* (Myrtaceae); MHNG, dry. • 6 ♂, 8 ♀; same but summit region; 6.0687°N, 116.5617°E; 3890 m; 30.iv.1982; D. Burckhardt leg.; #F8283; subalpine scrub, on *Coprosma hookeri* (Rubiaceae); MHNG, NHMB, dry, slide. • 1 ♂, 1 ♀; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #13a; moss forest with Ericaceae and

Myrtaceae; MHNG, dry. • , 2 ♀; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8756; moss forest with Ericaceae and Myrtaceae, on *Leptospermum recurvum* (Myrtaceae); MHNG, dry. • 1 ♂; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8757; moss forest with Ericaceae and Myrtaceae, on *Myrica javanica* (Myricaceae); MHNG, dry. • 11 ♂, 14 ♀; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8758; moss forest with Ericaceae and Myrtaceae, on *Photinia davidiana* (Rosaceae); MHNG, dry. • 1 ♂; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8759; moss forest with Ericaceae and Myrtaceae, on *Vaccinium* sp. (Ericaceae); MHNG, dry. • 1 ♀; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8760; moss forest with Ericaceae and Myrtaceae, on *Rhododendron* sp. (Ericaceae); MHNG, dry. • 1 ♂, 1 ♀; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8762; moss forest with Ericaceae and Myrtaceae, on *Rhododendron* sp. (Ericaceae); MHNG, dry. • 3 ♂; same but summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8765; moss forest with Ericaceae and Myrtaceae, on *Rhododendron rugosum* (Ericaceae); MHNG, dry. • 35 ♂, 38 ♀; same but below Laban Rata; 3155 m; 5.v.1987; A. Smetana leg.; MHNG, dry. • 4 ♂, 3 ♀; same but Laban Rata; 3200 m; 4–8.v.1987; A. Smetana leg.; interception trap; MHNG, dry. • 1 ♂, 4 ♀; same but Laban Rata; 3200 m; 9–20.v.1987; A. Smetana leg.; interception trap; MHNG, dry. • 3 ♂, 4 ♀; same but base of St. John's Peak; 3450–4000 m; 20.v.1987; A. Smetana leg.; MHNG, dry. • 5 ♂, 4 ♀; same but base of St. John's Peak; 4000 m; 7.v.1987; A. Smetana leg.; MHNG, dry. • 2 ♂, 2 ♀; same but base of St. John's Peak; 4000 m; 8.viii.1988; A. Smetana leg.; #B88; MHNG, dry. • 3 ♀; same but summit trail; 3900 m; 30.iv.1982; B. Hauser leg.; Sab-82/21; Berlese leaf litter; MHNG, dry. • 4 immatures; same but summit trail; 3900 m; 30.iv.1982; B. Hauser leg.; Sab-82/21; Berlese leaf litter; MHNG, slide. • 1 ♂; same but summit trail, near Panar Laban; 3270 m; 30.iv.1982; B. Hauser leg.; Sab-82/22; Berlese leaf litter; MHNG, dry. • 1 ♂; same but summit trail, near Panar Laban; 1850 m; 28.iv.1982; B. Hauser leg.; Sab-82/26; Berlese leaf litter; MHNG, dry.

Diagnosis. Adult. Vertex 0.4–0.5 times as long as wide; genal processes 0.9–1.2 times as long as vertex along midline, strongly narrowing basally, almost cylindrical otherwise, blunt apically, axis subparallel, separated in the middle. Antenna 1.8–2.0 times as long as head width; relative length of flagellar segments as 1.0 : 0.7 : 0.6 : 0.6 : 0.6 : 0.4 : 0.2 : 0.2. Metatibia with very small genual spine. Forewing oblong-oval, widest in the middle, 3.6–3.8 times as long as head width, 2.3–2.5 times as long as broad, costal margin curved; pterostigma moderately long, irregularly narrowing to apex, with subparallel margins in the middle, ending above bifurcation of vein M; vein Rs distinctly curved in the middle; m_1 cell value 2.2–2.7, cu_1 cell value 2.5–3.0; veins beset with short setae; surface spinules present in all cells, leaving narrow spinule-free stripes along the veins; absent from basal third of cell c+sc; fields of surface spinules in each of the marginal cells widening to wing margin; relatively evenly spaced forming irregular rhombs or squares. Male proctiger tubular, weakly sinuate, 0.4 times as long as head width. Subgenital plate strongly sclerotised, in lateral view subglobular, with almost straight dorsal margin. Paramere shorter than proctiger, in lateral view, lamellar, weakly curved, with strongly sclerotised apical hook curved inwards and forwards; inner face with a subapical group of long bristles, and long setae along anterior and posterior margin. Distal segment of aedeagus bearing hook-shaped apical inflation. Female proctiger 0.8 times as long as head width; dorsal margin weakly concave, apex blunt. Female subgenital plate 0.5–0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex. – Fifth instar immature. Body 1.2–1.3 times as long as wide. Antenna 1.1–1.2 times as long as forewing pad; segments 4–6 1.0–1.1 times as long as segment 7; lacking capitate setae on flagellum. Meso and metatibia with two long capitate setae. Forewing pad with 10–14 medium long and long marginal capitate setae, lacking dorsal macroscopic setae; hindwing pad with 2 long, marginal capitate setae subapically, lacking dorsal macroscopic setae. Caudal plate 0.6 times as long as wide; lacking marginal sectasetae; with 7–8 long marginal, 3 long submarginal and 1–3 short dorsal capitate setae (one side only); margin of caudal plate wavy. Outer circumanal ring small, its length along longitudinal body axis much larger than its distance from caudal margin of caudal plate; indented anteriorly, closed anteriorly; consisting of a single row of narrowly oval pores.

Description. Adult. ***Colouration.*** Head and thorax mostly reddish brown, abdomen black (Fig. 7). Head (Fig. 8) with occiput, coronal suture, foveae and fore margin of vertex almost black, base of vertex and anterior tips of vertex white; genal processes yellow. Antennal segments 1–3 dirty yellowish, segment 4 brown, segments 4–10 almost black. Pronotum white with each a lateral and sublateral dark brown dot on either side. Mesopraescutum with two sublateral longitudinal stripes in anterior half and white dots at posterior margin. Mesoscutum with dark brown longitudinal stripes. Mesoscutellum, in anterior half, black medially, white laterally. Metascutellum yellowish. Metapostnotum almost black. Fore and mid legs and metafemora brown. Fore and mid legs with femora basally dark greyish brown and apically yellow, tibiae and basitarsi dirty yellow and apicotarsi dark brown; hind leg with coxa brown anteriorly, ochreous posteriorly, femur and apicotarsus dark brown and tibia and basitarsus whitish. Forewing membrane whitish, transparent; veins light brown in basal half darkening to brown in apical half. Abdominal intersegmental membrane orange brown.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body length ♂ 3.0–3.4 mm, ♀ 2.9–3.9 mm (10 ♂, 10 ♀). Head deflexed 45–80° from longitudinal axis of body (Fig. 7); as wide as mesoscutum. Vertex (Fig. 8) rhomboidal, 0.4–0.5 times as long a wide, concave at base, bearing microscopic setae and imbricate microsculpture; preocular sclerite narrow; genal processes 0.9–1.2 times as long as vertex along midline, strongly narrowing basally, almost cylindrical otherwise, blunt apically, axis subparallel, separated in the middle, evenly beset with sparse long setae, apex blunt (Fig. 8); eyes hemispherical. Rostrum 0.4–0.5 times as long as head width, in lateral view mostly hidden by mesosternum and only apical segment visible. Antenna 1.8–2.0 times as long as head width; relative length of flagellar segments as 1.0 : 0.7 : 0.6 : 0.6 : 0.6 : 0.4 : 0.2 : 0.2; antennal segment 3 longest; relative length of segment 10 and terminal antennal setae as 1.0 : 1.7 : 1.5. Metatibia 0.7–0.8 times as long as head width, with very small genual spine, weakly widening to apex, with 1+3+1 apical spurs. Forewing (Fig. 12) oblong-oval, widest in the middle, 3.6–3.8 times as long as head width, 2.3–2.5 times as long as broad, costal margin irregularly curved, relatively evenly rounded apically; pterostigma moderately long, at base narrower than adjacent part of cell r_1, irregularly narrowing to apex, with subparallel margins in the middle, ending above bifurcation of vein M; vein C+Sc weakly, relatively evenly curved; vein M+Cu longer than half length of R; vein Rs distinctly curved in the middle; m_1 cell value 2.2–2.7, cu_1 cell value 2.5–3.0; veins beset with short setae; surface spinules present in all cells, leaving narrow spinule-free stripes along the veins; absent from basal third of cell c+sc; fields of surface spinules in each of the marginal cells widening to wing margin; relatively evenly spaced forming irregular rhombs or squares.

Male terminalia as in Figs 22–24. Proctiger tubular, weakly sinuate, 0.4 times as long as head width; densely beset with long, setae in apical three quarters. Subgenital plate strongly sclerotised, in lateral view subglobular, with almost straight dorsal margin; sparsely beset with long setae along a broad transverse band stretching from dorsal margin to postero-ventral margin. Paramere shorter than proctiger, in lateral view, lamellar, weakly curved, with strongly sclerotised apical hook which is curved inward and forward; parameres in caudal view, forming O with dorsally widening margins; outer face sparsely beset with long setae in apical two thirds; inner face with a subapical group of long bristles, and long setae along fore and hind margin. Aedeagus long and slender; distal segment bearing hook-shaped apical inflation; sclerotised end tube of ductus ejaculatorius short, sinuate. – Female terminalia cuneate (Fig. 33). Proctiger 0.8 times as long as head width, 3.0–3.5 times as long as circumanal ring which consists of two unequal rows of pores; dorsal margin weakly concave, apex blunt; beset with moderately long setae in basal half, with a transverse row of 4 very long setae in apical third, a submedian longitudinal row of slightly shorter setae in apical third, and a lateral band of peg setae on either side in apical third. Subgenital plate 0.5–0.6 times as long as proctiger, in lateral view, irregularly narrowing to pointed apex; except for base beset with long setae, with a lateral band of peg setae in apical third on either side. Dorsal and ventral valvulae curved, the latter with a ventral denticle; lateral valvula irregularly rounded apically.

Measurements in mm (3 ♂, 3 ♀). Head width 0.70–0.78; antenna length 1.36–1.48; forewing length 2.56–2.80; length of male proctiger 0.28–0.30; paramere length 0.20–0.22; length of distal segment of aedeagus 0.20–0.22; female proctiger length 0.56–0.60.

Fifth instar immature. Colouration of slide mounted specimens. Dorsal sclerites light brown, membranes colourless. Cephalothorax yellow anteriorly, becoming gradually darker towards the rear. Antennal segments 1–3 yellow, segments 4–6 brown, segment 7 dark brown. Thoracic and basal abdominal sclerites slightly darker than wing pads and caudal plate. Legs yellow, tarsi light brown.

Structure. Conforming to the generic description of Ossiannilsson (1992). Body (Fig. 37) 1.2–1.3 times as long as wide. Antenna 7-segmented, 1.1–1.2 times as long as forewing pad; segments 4–6 1.0–1.1 times as long as segment 7; lacking capitate setae on flagellum. Thoracic tergites small. Meso- and metatibia with two long capitate setae. Forewing pad broad, rounded apically, with 10–14 medium long and long marginal capitate setae, lacking dorsal macroscopic setae; hindwing pad with 2 long, marginal capitate setae subapically, lacking dorsal macroscopic setae. Caudal plate 0.6 times as long as wide; lacking marginal sectasetae; with 7–8 long marginal, 3 long submarginal and 1–3 short dorsal capitate setae (one side only) (Fig. 38); margin of caudal plate wavy. Outer circumanal ring (Fig. 39) small, its length along longitudinal body axis much larger than its distance from caudal margin of caudal plate; indented anteriorly, complete (closed) anteriorly; consisting of a single row of narrowly oval pores.

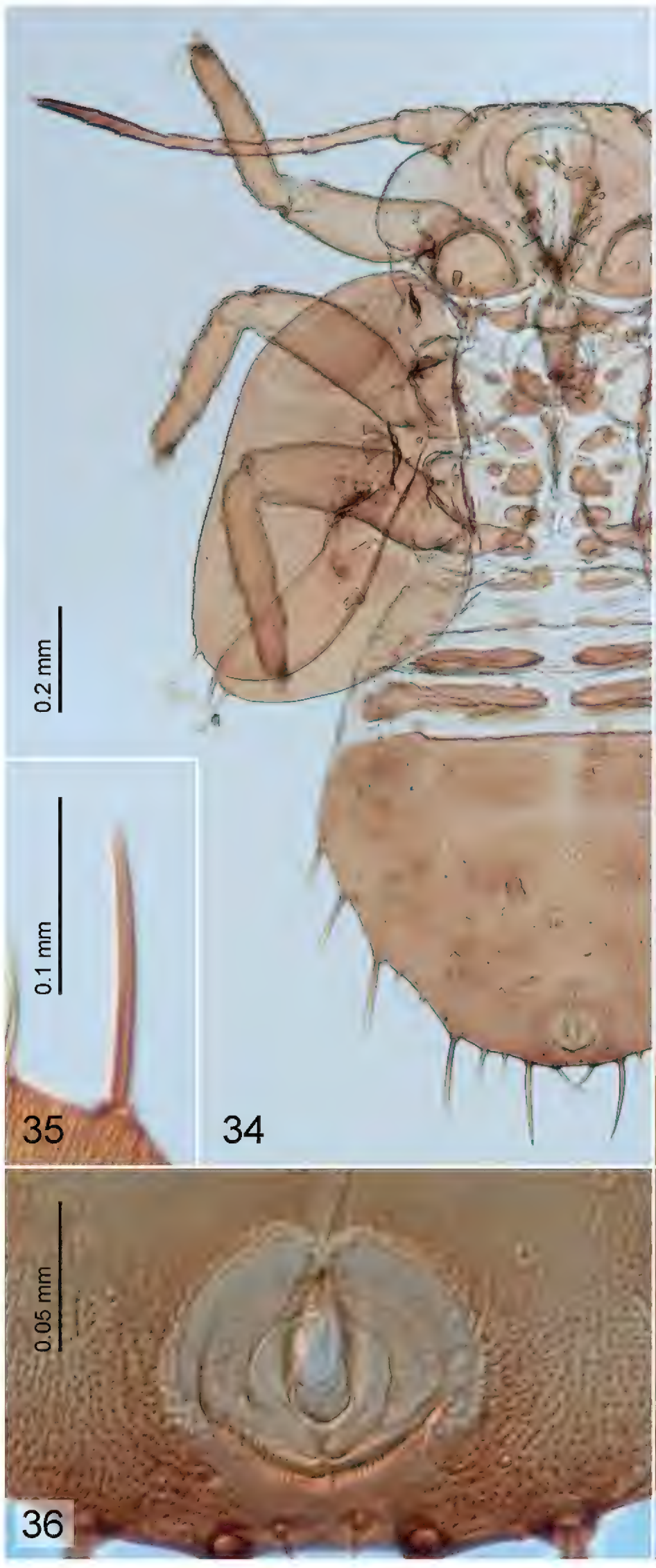
Measurements (in mm) (2 individuals). Body length 1.62–1.66; antennal length 0.84; length of forewing pad 0.70–0.74.

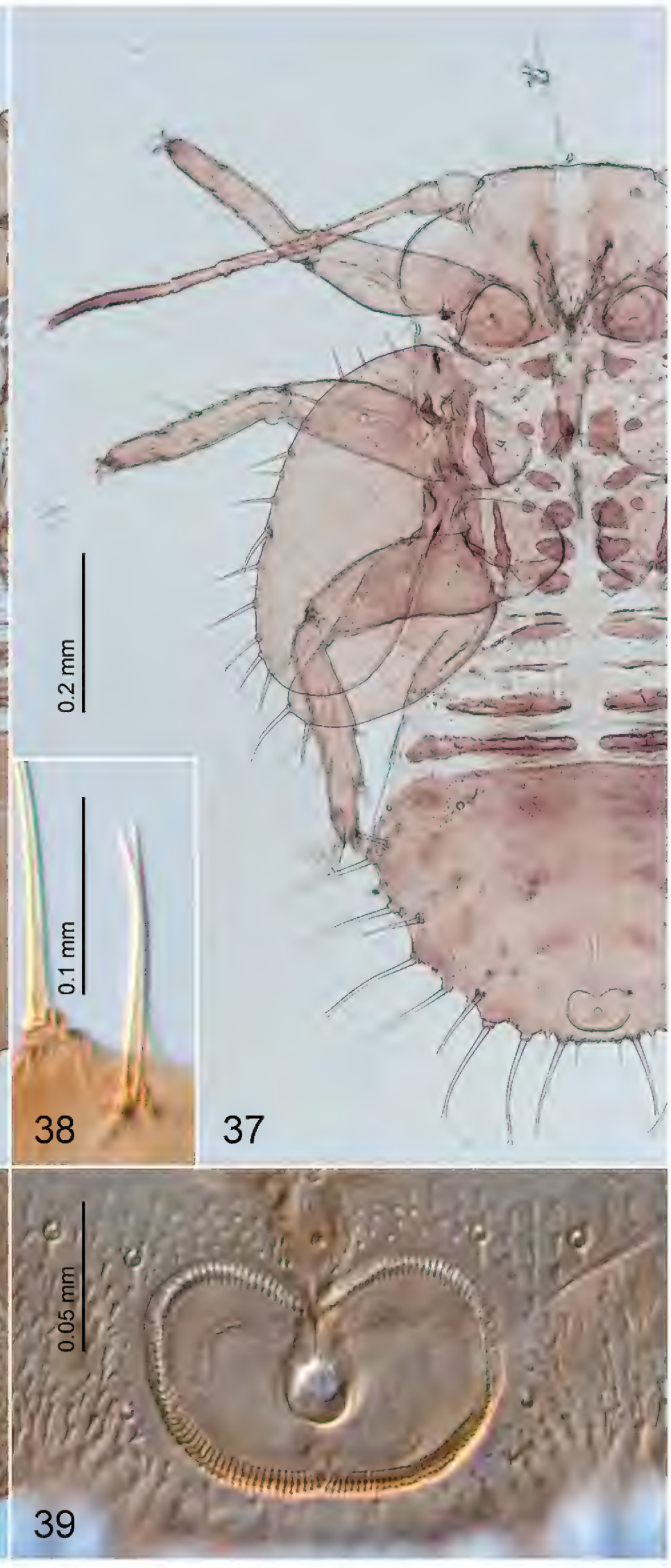
Etymology. Named after its host, *Photinia*.

Distribution. Malaysia: Sabah, Gunung Kinabalu, at altitudes between 3200–4000 m. The single male extracted with Berlese funnels from a sample taken at 1850 m was probably blown there by the wind.

Host plant, biology and habitat. *Photinia davidiana* (Decne.) Cardot (Rosaceae), a shrub or tree that is native to Borneo, Sumatra, Vietnam, the PR China and Taiwan (POWO 2023). *Cacopsylla photiniae* was found in moss forest with Ericaceae and Myrtaceae and in subalpine scrub.

Comments. *Cacopsylla photiniae* resembles *C. laricirubera* Li, 2011 in the lamellar paramere with a large, strongly sclerotised apical hook and the lens-shaped apical dilation of the distal aedeagal segment. The latter species is known only from a few adults from the Ningxia Hui Autonomous Region (PR China) collected on conifers.





Figures 34–39. *Cacopsylla* spp., fifth instar immature. **34, 37.** Habitus, in dorsal view, left side; **35.** Long, thick, apically pointed marginal seta; **38.** Short dorsal capitate seta; **36, 39.** Circumanal ring; **34–36.** *C. myrsines*; **37–39.** *C. photiniae*.

Cacopsylla photiniae differs from *C. laricirubera* in the longer genal processes (about as long as coronal suture versus two thirds length of coronal suture), in the basally hardly (versus strongly) incised apical hook on the paramere, and in the shorter (versus longer) female terminalia. From Palaearctic *Cacopsylla* species associated with Rosaceae, *C. photiniae* differs in the fields of surface spinules of the forewing widening (versus narrowing) to the wing margin and the small (versus moderately large) circumanal ring of the fifth instar immature. In both these characters, it resembles the *Cacopsylla* species associated with Ericaceae with which it may be more closely related

(cf. comment under *C. graciliforceps*). *Cacopsylla photiniae* differs from these species in details of the male and female terminalia.

Psylla cirrita sp. nov.

https://zoobank.org/9E5153AE-1D6A-418C-A554-8869C6CE97E7

Figs 40, 41, 44–47

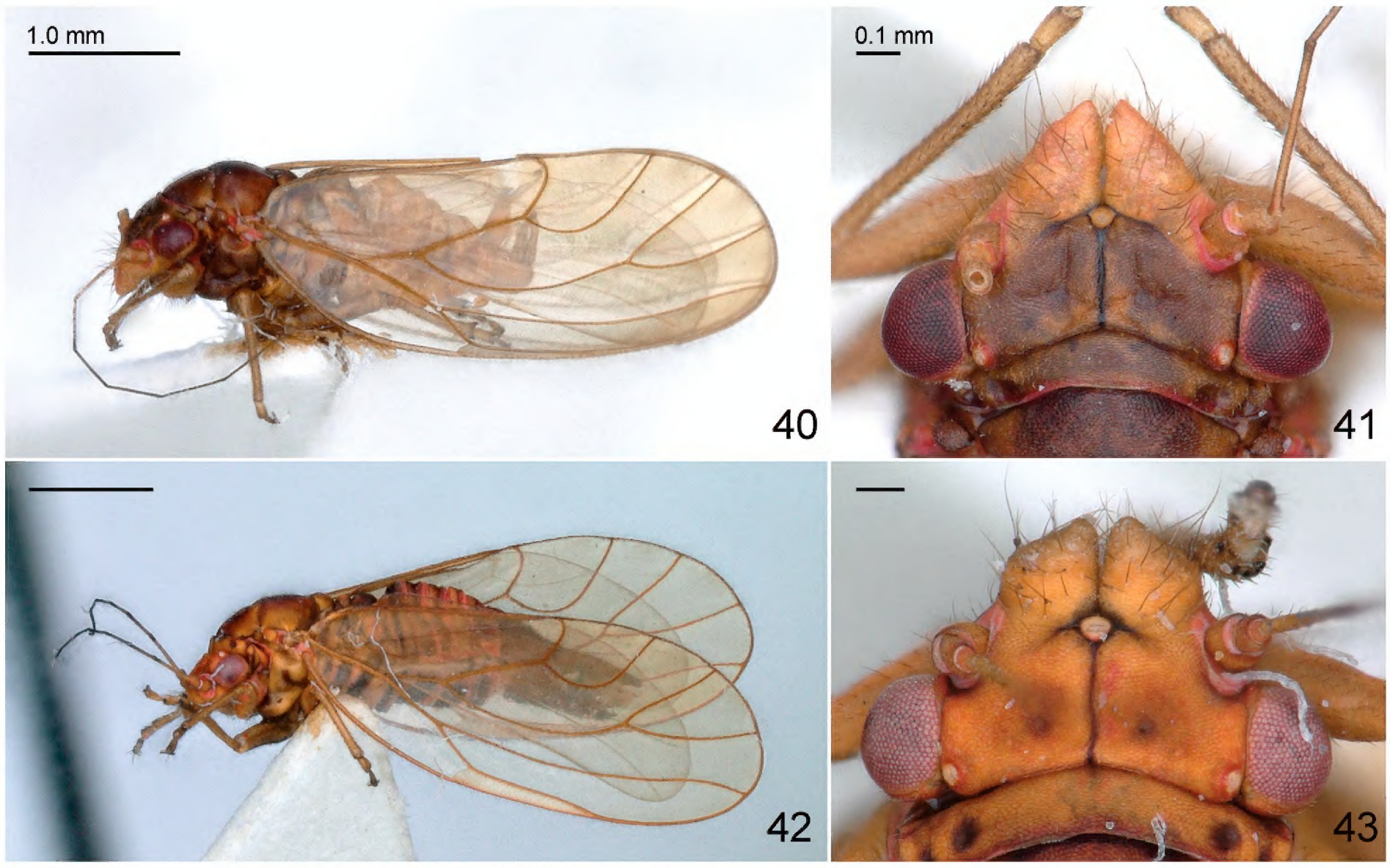
Type locality. Malaysia, Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, Panar Laban; 6.0594°N, 116.5665°E, 3300 m.

Material examined. ***Holotype.*** Malaysia • ♂; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8764; on *Rhododendron* sp. (Ericaceae) in moss forest with Ericaceae and Myrtaceae; MHNG, dry.

Diagnosis. Adult. Vertex 0.4 times as long as wide; genal processes 1.0 times as long as vertex along midline, massive, evenly tapering to pointed apex, contiguous medially. Antenna 2.6 times as long as head width; relative length of flagellar segments as 1.0 : 1.0 : 0.9 : 1.1 : 1.2 : 1.2 : 0.2 : 0.3. Metatibia bearing small genual spine. Forewing oblong-oval, widest in the middle, 3.2 times as long as head width, 2.4 times as long as broad; pterostigma regularly narrowing to apex, ending level with the middle of Rs; vein Rs weakly sinuate; vein M long, with relatively short, weakly diverging branches; vein Cu_{1a} strongly curved in basal half. Surface spinules present in all cells, leaving spinule free stripes along the veins; forming irregular transverse rows. Male proctiger tubular, weakly sinuate, 0.4 times as long as head width. Subgenital plate strongly sclerotised, in lateral view subglobular, with almost straight dorsal margin. Paramere shorter than proctiger, in lateral view, lamellar, weakly curved, with strongly sclerotised apical hook, curved inwards and forwards. Distal segment of aedeagus bearing hook-shaped apical inflation.

Description. Adult. ***Colouration.*** Dark reddish brown. Genal processes ochreous. Antenna dark brown, segments 1–3 brown, apices of segments 3–8 and entire segments 9 and 10 almost black. Mesoscutum with four indistinct longitudinal brown stripes; mesoscutellum reddish brown laterally; metanotum and metapostnotum ochreous. Legs irregularly ochreous; apical tarsal segments greyish brown. Forewing colourless at base, becoming yellow towards apex; veins brown. Abdomen including terminalia yellowish; tip of paramere black.

Structure. Conforming to the generic description of Li (2011). Body length 4.7 mm (1 ♂). Head deflexed 45° from longitudinal axis of body (Fig. 40); about as wide as mesoscutum. Vertex (Fig. 41) rhomboidal, 0.4 times as long a wide, weakly concave at base, bearing short sparse setae and fine granular microsculpture; preocular sclerite narrow; genal processes 1.0 times as long as vertex along mid-line, massive, evenly tapering to pointed apex (Fig. 41), contiguous medially, evenly beset with sparse long setae; eyes hemispherical. Rostrum short, in lateral view mostly hidden by mesosternum and only apical segment visible. Antenna 2.6 times as long as head width; relative length of flagellar segments as 1.0 : 1.0 : 0.9 :



Figures 40–43. *Psylla* spp. **40, 42.** Habitus, in lateral view; **41, 43.** Head, in dorsal view. **40, 41.** *P. cirrita*; **42, 43.** *Psylla* sp.

1.1 : 1.2 : 1.2 : 0.2 : 0.3; antennal segments 7 and 8 longest; relative length of segment 10 and terminal antennal setae as 1.0 : 0.6 : 0.6. Metatibia 0.7 times as long as head width, bearing small genual spine, weakly widening to apex, with 1+4+1 apical spurs. Forewing (Fig. 40) oblong oval, widest in the middle, 3.2 times as long as head width, 2.4 times as long as broad, irregularly rounded apically; pterostigma, at base narrower than adjacent part of cell r_1, regularly narrowing to apex, ending level with the middle Rs; vein C+Sc weakly curved, cell c+sc long, widest in the middle; vein Rs weakly sinuate; vein M long, with relatively short, weakly diverging branches; vein Cu_{1a} strongly curved in basal half. Surface spinules present in all cells, leaving spinule free stripes along the veins; forming irregular transverse rows.

Male terminalia as in Figs 44–47. Proctiger tubular, weakly sinuate, 0.4 times as long as head width; densely beset with long setae in apical three quarters. Subgenital plate strongly sclerotised, in lateral view subglobular, with almost straight dorsal margin; sparsely beset with long setae along a broad transverse band stretching from dorsal margin to postero-ventral margin. Paramere shorter than proctiger, in lateral view, lamellar, weakly curved, with strongly sclerotised apical hook which is curved inward and forward; parameres in caudal view, forming O with dorsally widening margins; outer face sparsely beset with long setae in apical two thirds; inner face with a subapical group of long bristles, and long setae along fore and hind margin. Aedeagus long and slender; distal segment bearing rounded apical inflation; sclerotised end tube of ductus ejaculatorius short, sinuate. – Female unknown.

Measurements in mm (1 ♂). Head width 1.12; antenna length 2.88; forewing length 3.56; male proctiger length 0.40; paramere length 0.38; length of distal portion of aedeagus 0.28.

Fifth instar immature unknown.

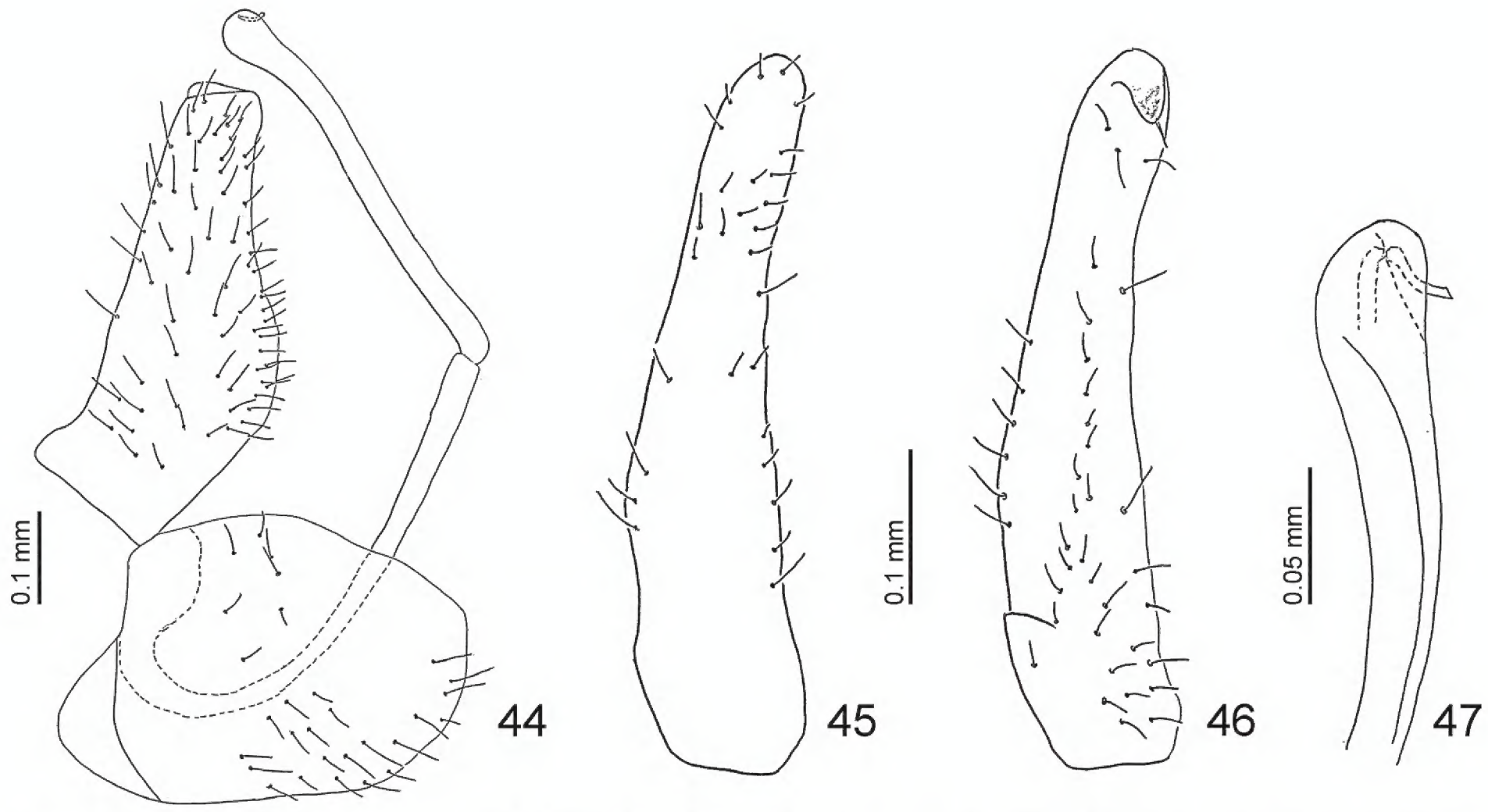
Etymology. From Latin cirritus = having filaments, bearded, referring to the conspicuous setae on the genal processes.

Distribution. Malaysia: Sabah, Gunung Kinabalu, at an altitude of 3300 m.

Host plant, biology and habitat. Unknown; the holotype was collected on *Rhododendron* sp. (Ericaceae) in moss forest with Ericaceae and Myrtaceae.

Comments. *Psylla cirrita* shares with *Psylla turpinae* Li & Yang from the Guangxi Zhuang Autonomous Region (PR China) the reddish body colour, the massive genal processes, the 1+4+1 apical metatibial spurs, the postero-basally expanded male proctiger and the apically hardly expanded distal segment of the aedeagus. It differs from *P. turpinae* in the pointed (versus blunt) genal processes, the antennal segment 3 that is shorter (versus longer) than segments 7 and 8, and the curved (versus sinuate) parameres. If the similarity between the two species reflects a phylogenetic relationship, this needs to be tested with more material and, in particular, with immatures. A related, undescribed species was found on Gunung Kinabalu (see comments under *Psylla* sp.). According to Li (2011), *P. turpinae* develops on *Dalrympelea pomifera* Roxb. (Staphyleaceae), an unusual psyllid host taxon. It is interesting to note, that of the eight species recognised in the Southeast Asian genus *Dalrympelea* six occur in Borneo (POWO 2023).

Psylla cirrita and *P. turpinae* are not congeneric with *P. alni* (Linnaeus, 1758), the type species of *Psylla* Geoffroy, 1762. Based on molecular and morphological evidence, *Psylla* was redefined to include Holarctic species



Figures 44–47. *Psylla cirrita*. **44.** male terminalia, in lateral view; **45.** outer face of paramere; **46.** inner face of paramere; **47.** apex of distal aedeagal segment.

developing on Betulaceae (Burckhardt et al. 2021). The two Asian species possibly constitute a new genus but more material including immatures is necessary to examine their phylogenetic position. Meanwhile, I use the broad concept of *Psylla* by Li (2011).

Psylla sp.

Figs 42, 43

Material examined. Malaysia • 1 ♀; Sabah, Ranau, Gunung Kinabalu, Kinabalu Park, summit trail, Panar Laban; 6.0594°N, 116.5665°E; 3300 m; 4.v.1987; D. Burckhardt and I. Löbl leg.; #F8763; on *Rhododendron* sp. (Ericaceae) in moss forest with Ericaceae and Myrtaceae; MHNG, dry. • 1 ♂; same data but Kinabalu Park, summit trail below Layang Layang; 6.0419°N, 116.5578°E; 2560 m; 1.v.1987; D. Burckhardt and I. Löbl leg.; #F8735; on *Syzygium* sp. (Myrtaceae) in moss forest; MHNG, dry.

Comments. A teneral male and a female (Fig. 42) at hand resemble *Psylla cirrita* in general but differ in the shape of the genal processes (pointed, Fig. 41, versus obliquely truncate, Fig. 43), and the relative lengths of antennal segments 3, 7 and 8 (segment 3 shorter versus longer than segments 7 and 8). There are slight differences in the male terminalia but they are difficult to interpret as the male of *Psylla* sp. is teneral and the terminalia may not be fully developed.

Discussion and conclusions

Only fragments of the diversity of tropical psyllids are known and often new species do not fit, or only partially fit, into described genera. *Cacopsylla graciliforceps*, *C. myrsines* and *C. photiniae* correspond to the putatively monophyletic concept of *Cacopsylla* by Ossiannilsson (1992) and Percy et al. (2018). The presence of immatures in the last two species confirms this generic placement. *Cacopsylla graciliforceps* resembles species associated with Ericaceae, including some undescribed species from Nepal (unpublished NHMB data), and *C. myrsines* is morphologically similar to some Palaearctic species developing on Elaeagnaceae. *Cacopsylla photiniae*, though developing on a rosaceous host, differs morphologically from west Palaearctic species associated with Rosaceae. It is more similar to species developing on Ericaceae with which it may be related. *Cacopsylla kinabaluensis*, *C. aranetae* and *C. bakeri* differ from other *Cacopsylla* species in the short vertex, the tubular, medially separated genal processes and the long antennae. Immatures and molecular data will be necessary to analyse their phylogenetic relationship within the subfamily. The situation of *Psylla cirrita* and *P. turpinae* is similar. The two species probably warrant the erection of a new genus but without additional material, in particular immatures with host information, the two species are kept in the polyphyletic *Psylla* as adopted by Li (2011). The five new species described here bring the total number of known psyllid species from Gunung Kinabalu to 22.

Host plants are only known for two of the five species described here. *Cacopsylla myrsines* develops on *Myrsine dasyphylla* (Primulaceae), an endemic of Borneo. *Myrsine* was previously reported only once as psyllid host: of *Trioza* sp. from New Zealand (Dale 1985). Primulaceae in general is an atypical psyllid host (Ouvrard 2023). Another confirmed host is *Lysimachia ciliata* of *Aphalara steironemicola* Richards, 1970. *Photinia davidiana* (Rosaceae) hosts, apart from *C. photiniae*, also the unrelated Taiwanese *C. stranvaesiae* (Yang, 1984). It is a shrub or tree native to Southeast Asia, Central and South China and Taiwan (POWO 2023). *Cacopsylla graciliforceps* probably develops on Ericaceae, a host taxon utilised also by other *Cacopsylla* species (see comment under *C. graciliforceps*). The hosts of *C. kinabaluensis* and *P. cirrita* are unknown, and as their phylogenetic relationships are unknown, it is impossible to predict their hosts. It is interesting to note that adults of the Chinese *Psylla turpinae*, a possibly close relative of *P. cirrita*, were collected on *Dalrympelea pomifera* Roxb. (Staphyleaceae) (Li 2011), a plant genus comprising eight species of which six are endemic to Borneo (POWO 2023).

Cacopsylla graciliforceps, *C. myrsines* and *C. photiniae* occur at altitudes of 2600–4000 m and are probably most closely related to species in the Himalaya and temperate Palaearctic. They represent Himalayan elements similar to those found in the flora (Cockburn 1978; Corner 1978; Beaman and Beaman 1990). The biogeographical relationships of *C. kinabaluensis* and *P. cirrita* remain unclear as their phylogenetic relationships are unknown.

Psyllid species are usually quite widespread (Ouvrard 2023). The few examples of narrowly endemic species are restricted to mountains (Burckhardt and Queiroz 2021; Burckhardt 2022) or islands (Percy 2000, 2017; Bastin et al. 2023). The vast majority of psyllids known from Gunung Kinabalu, including all the new species described here, are known only from there. Exceptions are three species of *Paurocephala*, which also occur outside Borneo (Mifsud and Burckhardt 2002; Burckhardt et al. 2023), and one species of *Boreioglycaspis*, which is also known from other localities in Borneo (Burckhardt 1991). *Paurocephala* represents an Oriental faunal element characteristic of the lower altitudes. With additional targeted fieldwork in Borneo and other Southeast Asian regions, it is likely that some of the species currently known only from Gunung Kinabalu may be found also elsewhere, although the degree of endemism would still be high.

Acknowledgements

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